

## Passenger detector

The present application is a continuation of PCT/EP99/08375 having an  
5 International filing date of November 3, 1999, which PCT application is  
incorporated herein by reference.

The present invention relates to a passenger detector, which is used to  
detect the presence of a passenger on the seat of a vehicle and/or said  
passenger's position on said seat. Such a detector has a particular application  
10 in controlling a motor vehicle protection system such as airbags.

In order to protect the life of passengers during a traffic accident, modern  
vehicles are generally fitted with a protection system comprising several airbags  
and seat belt pretensioners, which are used to absorb the energy of a  
15 passenger released during the collision due to the accident. In order to deploy  
the airbags of the passenger seat only in the case where this seat is actually  
occupied by a person, passenger detectors have been developed that indicate  
the presence of a passenger to the control unit of the protection system.

20 Such a detector is described, for example, in the document  
DE-A-42/37 072. It concerns a pressure detector integrated into the passenger  
seat, which comprises two insulating substrates placed one above the other and  
separated by a certain distance using a separator. The separator comprises, for  
example, a two-sided adhesive band which is cut in such a way as to surround

at least in part the active zones of the detector. Inside the active zones, one of the supporting sheets is provided with two electrode structures made of a conducting material separated from each other, while the other supporting sheet is provided with a coating of a pressure-sensitive semiconducting material. The  
5 semiconducting material has microprojections on the surface so that the surface resistance between the layer and a conductor decreases when the layer is pressed on to the conductor.

When the passenger seat is unoccupied, i.e. when no pressure is acting  
10 on the passenger detector, the layer of semiconducting material is not in contact with the two electrodes and the electrical resistance between the two electrodes is consequently very high. If, on the contrary, a person is sitting on the seat, the two supporting sheets are pressed together and the pressure-sensitive layer is put into contact with the two electrodes. This produces, between the two  
15 electrodes, a short circuit whose electrical resistance varies inversely with the value of the applied pressure. The greater the pressure on the sensor, the more the semiconducting layer is compressed or the more it comes into intimate contact with the electrodes, and the more the resistance measured between the two electrodes decreases.

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The document DE 197/38 531 describes a resistance varying with pressure comprising a first substrate and a second substrate. A layer of conducting material is printed on the first substrate, which carries insulating particles having a diameter greater than the thickness of the layer. On the

second support two electrodes are arranged at a distance from each other. The two substrates are then laminated together, the insulating particles forming separators to prevent contact between the conducting layer and the electrodes when no pressure is exerted on the sensor.

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Another laminated pressure sensor is described in the document WO-A-97/18450. It concerns a sensor for measuring the pressure of a foot, comprising piezoelectric sensors inserted in a flexible structure as in a sandwich

10 One disadvantage of such a detector lies in its high rigidity. In effect, due to the lamination of the two supporting sheets using an adhesive band, the detector is quite thick and has a high resistance to bending or twisting, which significantly reduces its flexibility. Consequently, the introduction of such a detector in the seat of a vehicle may have a detrimental effect on the comfort of  
15 the seat.

Another type of force sensor is described in the document "Robotics and power semiconductors join forces to meet the challenges of the automated factory environment" – Electronic Design, vol. 31, no 10, May 1983 (1983-05),  
20 pages 97-111, XP002092415, Waseca, MN, Denville, NJ, USA. This document describes a force sensor comprising two electrode structures placed one on top of the other. The first of these electrode structures is placed on a silicon substrate, while the second is formed by a conducting elastomer. Placed between these two structures is an insulating layer separating the two

electrodes when no force is acting on the sensor. It is clear that, due to its rigid support, such a sensor is in no way suitable for being integrated into a car seat.

The objective of the present invention is to propose a passenger detector  
5 that does not have this disadvantage.

This objective is attained by a passenger detector comprising a flexible support of an insulating material, at least two electrode structures placed on said insulating substrate at a distance from each other, and a layer of  
10 semiconducting material placed on the top of said electrode structures in an active zone of the detector. In conformity with the invention, said layer of semiconducting material has an internal resistance that varies with a deformation of said layer, and said layer of semiconducting material is placed in intimate contact with said electrode structures.

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It should be noted that the internal resistance of the semiconducting layer may vary not only with a compression of the layer but also with a bending or any other deformation of the layer. Moreover, the internal resistance of the layer  
~~may vary in the same sense as the deformation (e.g. the resistance increases~~  
20 when the pressure increases) or in the opposite sense of the deformation (e.g. the resistance decreases when the pressure increases).

The detector according to the present invention therefore has only one supporting sheet, on to which are deposited both the electrode structures and

the layer of semiconducting material. The rigidity conferred by the lamination of several layers no longer applies to the detector according to the present invention. Moreover, the passenger detector is not as thick as conventional detectors. Consequently, such a sensor causes much less discomfort when it is  
5 integrated into the seat of a vehicle and it therefore responds better to the demands of said seat as regards comfort.

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Moreover, manufacturing the detector according to the present invention may cost less than producing conventional detectors. In effect, the use of only a  
10 single supporting sheet reduces the consumption of supporting sheet by half. In addition, there is no longer any need for a separator in the form of a two-sided adhesive band.

In conventional detectors, the supporting sheets and the separator  
15 enclosed a space between them, which had to be connected to the environment using ventilation channels in order to allow an exchange of pressure. However, these ventilation channels made the sensors sensitive to humidity, which re-entered the detector together with the air from the environment. In the detector  
according to the invention, the ventilation channels are no longer necessary and  
20 the present detector forms a sensor that is closed and sealed, into which humidity can no longer enter.

Another advantage of the passenger detector described above is its lower susceptibility to production tolerances. In conventional detectors, the

precision with which the two supporting sheets are positioned with respect to each other is a crucial factor in the assembly of the detector. A slight offset between the two sheets would lead to insufficient coverage of the semiconducting layer and hence to the production of a detector that does not  
5 comply with specifications. In the new detector, all the layers are deposited, ~~printed or stuck on the same supporting sheet, which facilitates the positioning~~ of the various layers with respect to each other ("matching") and therefore leads to sensors with very low production tolerances. The production of sensors not complying with specifications is consequently significantly reduced, which  
10 increases the productivity of the production line.

In order to increase still further the flexibility of the passenger detector, said flexible support preferably comprises a woven or non-woven fabric. This may be a cloth, a knitted cloth or one that is non-woven and made of insulating  
15 synthetic fibres. Such a support has a very great flexibility in three dimensions and hence adapts very well to the three-dimensional surface of the seat. Moreover, such a fabric may be very thin and, in spite of that, may have a very high resistance to mechanical stress. Any destruction of the support due to  
~~fatigue is therefore ruled out.~~

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Another advantage of a fabric is its very high permeability to air and humidity. As a result, such a passenger detector does not form a barrier to humidity in the vehicle seat and hence completely satisfies all the requirements of said seat as regards comfort.

Said electrode structures are, for example, deposited or printed on the support of insulating material. Alternatively, said electrode structures are engraved or etched into a metallic layer deposited on said insulating support.

5 The deposition or printing, or the engraving or etching, of the electrode structures is advantageously carried out simultaneously with the deposition, printing, engraving or etching of conductors for heating the seat.

In a first advantageous execution, said layer of semiconducting material  
10 comprises a semiconducting ink that is printed on said electrode structures. The printing is carried out, for example, by the screen-printing process or according to the inkjet method.

In an alternative execution, said layer of semiconducting material  
15 comprises a conducting elastomer, granulated or non-granulated, which is deposited or stuck on to said electrode structures. Such a layer of semiconducting material has a better flexibility than layers of semiconducting ink.

20 It should be noted that the layer of semiconducting material is preferably divided into several zones, positioned at different places above said electrode structures and thus defining several active zones of said detector.

In order to protect the detector from corrosion, the detector preferably comprises a protective layer applied on to said electrode structures and said layer or layers of semiconducting material. Said protective layer may be, for example, a layer of an inert lacquer that is applied by simple immersion of the  
5 sensor in the lacquer.

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Because of its very great flexibility and its small thickness, the detector according to the present invention is very suitable for integration into a vehicle seat. Moreover, by virtue of these very advantageous characteristics, the  
10 present detector is compatible with many more seats than conventional detectors. In addition, the present detector is suitable for many more applications than a conventional detector.

In effect, a detector as described above may be integrated not only into  
15 the surface of the seat in order to detect the presence and/or the weight of any possible passenger, but also into the back of the seat and/or into the head-rest. When integrated into these places, the detector functions as a detector of position and may detect whether the passenger is resting against the back or  
~~the head-rest or whether the passenger is leaning forward. In the latter case,~~  
20 the functioning of the airbag system may, as a result, be modified. Similarly, such a detector may be easily integrated into the pads at the side of the seat in order to detect the lateral position of the passenger on said seat.



Apart from its applications in the seat, the passenger detector as described above may be integrated into the floor carpet in the body of the vehicle in order to detect whether or not the passenger's feet rest on the floor. Integrated into the seat belt, the detector may detect the passenger's position, 5 since the seat-belt's inertia wheel system exerts a greater tension on the belt as it is increasingly unwound.

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